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To: John L. Cutler, M.D., Ph.D.

From: Andrew M. Friede, M.D.

Date: August 27, 1984

Subject: Childhood Leukemia, Woburn, MA: An Update

Upon your request, I have reviewed the list of 25 putative cases of leukemia that were thought to have occurred to Woburn residents aged 0-19 from 1966 to the present. This list was furnished by the Reverend Bruce Young, of FACE, and was received in August, 1983. In addition, I have reviewed three additional cases who were treated at the Dana Farber Cancer Institute. This memorandum is a report of this investigation.

SOURCES OF INFORMATION

For information about cases that occurred before 1980, previous DPH (1) and CDC (2) reports were used. In addition, Suzanne Condon, who participated in the earlier study, was consulted. (There is one case, #19 [case numbers are those on the typed list from FACE], that was not previously described, although it occurred before 1980. The patient was over 19 years of age at time of diagnosis.) For cases that occurred from January 1980 to August 1983, hospital charts were reviewed and exact addresses were obtained by telephone from parents, and the Reverend Young. For the three cases provided by the Dana Farber, Dr. Steven Salan provided clinical information from the charts. Richard Clapp of the Massachusetts Cancer Registry provided cancer incidence rates from the Connecticut Cancer Registry. Robert Danley of the Division of Health Statistics provided 1970 and 1980 population data on Woburn from the US Census. Robert Cleary and Helen Waldorf of DEQE summarized their agency's work, and provided a draft copy of their most recent findings from soil samples.

FINDINGS

Epidemiological Investigation

First, the 28 cases were reviewed (Table 1). The important findings were for the period from January 1980 to December 1983. There were 7 new incident cases of childhood leukemia; these cases are marked on the map of Woburn (Figure 1), and described in Table 2. They occurred in a scattered geographic pattern, although 1 of the cases was in the Walker Pond area. They were all white; 5 of 7 were male; the age range was 22 months to 14 years; all had acute lymphocytic leukemia (ALL), with unambiguous clinical and histological

diagnoses. The dates of diagnosis were from 11/80 to 12/83. Two of 7 have died; 1 from unknown causes 9 months after diagnosis, the other from fulminant Salmonella enteritides meningitis 1 month after diagnosis. The 5 surviving children were seen in clinic on 5/15/84 and are doing well.

Next, expected and observed leukemia cases for Woburn were calculated. Although all the leukemias were ALL, because 3 of 12 cases before 1980 were other leukemias, expected cases were calculated for leukemia, all types. Similarly, because all the cases in both series of patients were age 0-14, the calculation of expected numbers of childhood leukemia was restricted to this age group. The data were modelled with a Poisson distribution, because the events were uniform, independent, and occurred with a uniform interval (see Figure 2). A finding was defined as being statistically significant if it occurred by chance alone with a probability of less than 0.05.

All 19 cases were combined, and general secular and geographic patterns were examined. Table 3 summarizes the observed and expected numbers by sex and age. Populations for the period January 1969 to August 1983 were calculated by averaging the 1970 and 1980 US Census figures. Not only was the aggregate number significantly elevated, but the number in several age groups was also significantly increased.

Table 4 summarizes the key findings, and further examines the role of gender. The rate of cancer occurring for boys alone, and for all children, was 3-times the expected.

The possible role of geography was examined in several ways. First, as described above, Figure 1 shows that the cases did seem to cluster around Walker Pond, although only 1 of 7 new cases occurred in census tract 3334, where the pond was located. Table 5 shows that the number of cases was significantly elevated in tracts 3331 and 3335 as well. It may only be that the small numbers keep the other tracts out of the range of the traditional criterion for statistical significance.

To examine other hypotheses for Woburn's elevated rate of childhood leukemia, the timing of leukemia by date of diagnosis (Figure 2) and date of birth (Figure 3) were examined. Timing by date of diagnosis showed no new pattern. As to clustering by date of birth, the 2 cases in older children fell over a year after the cluster noted in the first reports. In that cluster, 4 of 12 cases were born within a 6-month period in 1964 ($p<0.05$). In the entire series, only 2 cases (FACE #22, Dana Farber #3) were conceived after wells G and H were closed. (They were closed 5/79.)

The DEQE Soil Studies

On June 17 and 18, 1983, in an effort to associate specific pollutants with verified cases of childhood leukemia, the Department of Environmental Quality examined 34 soil samples for possible carcinogens: organic pesticides and industrial wastes, and metals. The samples were distributed as follows: 21 were from the residential yards and roadside soils of leukemia cases, 5 from Whitmore Pond margins, 6 at the Goodyear school, and 2 from West Woburn (the last as controls). Because of confidentiality rules, DEQE obtained addresses of cases from FACE and other local contacts. DEQE staff were

"reasonably" sure about 5 or 7 addresses; 1 of 7 was approximated; 1 of 7 was thought to be a new (as yet unconfirmed) case. The leukemia cases selected were those occurring right around Walker Pond. No single compound or group of compounds was found to be associated with the cases of leukemia. In addition, air samples were found to be normal.

CONCLUSIONS

The number of cases of leukemia in Woburn was significantly higher than expected. This was true for several age and sex groups, and 3 of 6 census tracts. It may have been true for all subgroups if the numbers had been larger. There were no epidemiologic characteristics that helped to identify specific risk factors. The DEQE soil sampling program failed to identify a pollutant that was associated with the leukemia cases. Because only 2 cases were conceived after wells G and H were closed, it is too soon to reach conclusion about their possible role. The problem of excess leukemia in Woburn children continues, and there is no explanation.

RECOMMENDATIONS.

1. The DPH should continue epidemiologic surveillance of Woburn.

2. DEQE should perform further environmental testing when firm hypotheses have been generated by the epidemiology, or by new findings in the literature.

REFERENCES

1. Parker, G.S., Rosen, S.L. Woburn: cancer incidence and environmental hazards 1969-1978. Boston: Massachusetts Department of Public Health, January 23, 1981.

2. Chronic Diseases Division. Cancer in Woburn, Massachusetts. Atlanta: Centers for Disease Control, EPI-80-37-2, September 16, 1981.

cc: Richard Clapp
Robert Danley

bj

TABLE 1. LIST OF 28 SUSPECTED CASES OF CHILDHOOD LEUKEMIA, IN WOBURN, MASSACHUSETTS: JANUARY 1969 - AUGUST 1983

I. 1966-1979: PERIOD OF FIRST REPORTS (N= 17)

2 not considered in earlier reports as diagnosis was before 1969 (1966 and 1968) (#1,#2)

1 omitted from original series as residence was in New Hampshire (daytime spent in Woburn) (#14)

1 omitted from original series because child symptomatic prior to moving to Woburn (#9)

1 absent from original case list, but age at diagnosis was 20 (#19)

12 considered in first reports (#3-8, #10-13, #15, #16)

II. JANUARY 1980 - AUGUST 1983: PERIOD OF THIS REPORT (N = 11)

1 moved to Georgia 9 years before diagnosis (#21)

1 never lived in Woburn; mother lived in Woburn during months 5-7 of this child's gestation (#23)

2 moved from Woburn 13 months and 26 months before diagnosis (#17, #25)

7 confirmed cases (#18, #20, #22, #24 from FACE, and 3 of 3 from Dana Farber) (detailed in Table 2)

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TABLE 2. CHARACTERISTICS OF 7 INCIDENT CASES OF LEUKEMIAS IN CHILDREN AGED 0-19 IN WOBURN, MASSACHUSETTS: JANUARY 1980 - DECEMBER 1983

ID #	Sex	Date of Birth	Diagnosis	Date of Diagnosis	Age at Diagnosis	Status
FACE						
#18	M	5/13/66	ALL	11/24/80	14 years	died 8/28/82
#20	M	3/25/79	ALL	6/22/82	3 years	died 7/20/82
#22	F	1/18/81	ALL	12/6/82	22 months	in remission 5/15/84
#24	M	1/12/80	ALL	3/4/83	3 years	in remission 5/15/84
Dana Farber						
# 1	M	5/20/68	ALL	9/15/81	13 years	in remission 5/15/84
# 2	F	12/12/74	ALL	10/5/83	9 years	in remission 5/15/84
# 3	M	11/26/80	ALL	12/8/83	3 years	in remission 5/15/84

TABLE 3. NUMBER OF OBSERVED AND EXPECTED CASES OF LEUKEMIA (ALL TYPES) BY AGE AND SEX IN WOBURN, MASSACHUSETTS: JANUARY 1969 - DECEMBER 1983

Sex	Age (yrs)	Number Observed	Number Expected	Poisson Probability	Previous + Poisson Probability
Male	<5	7***	2.04	0.01	0.054
	5-9	3	1.07	0.09	0.063
	10-14	4**	.88	0.01	0.156
	0-14	14	3.99		
Female	<5	1*	1.01	0.73	
	5-9	1*	0.53	0.41	
	10-14	3	0.48	0.01	0.006
	0-14	5	2.02		
Both	<5	8****	3.05		
	5-9	4*	1.60		
	10-14	7**	1.36		
	0-14	19	6.01	1.8×10^{-5}	0.0053

* Each asterisk represents one new case after 1979.

+ From reference (1); for period 1969-1979.

TABLE 4. STANDARDIZED INCIDENCE RATIOS FOR LEUKEMIA (ALL TYPES), BY SEX IN WOBURN, MASSACHUSETTS: JANUARY 1969 - DECEMBER 1983

Sex	Number Observed	Number Expected	Ratio	95% Confidence limits*
Male	12	3.99	3.00	1.55, 5.25
Female	4	2.02	1.98	0.54, 5.07
Both	19	6.01	3.16	1.90, 4.93

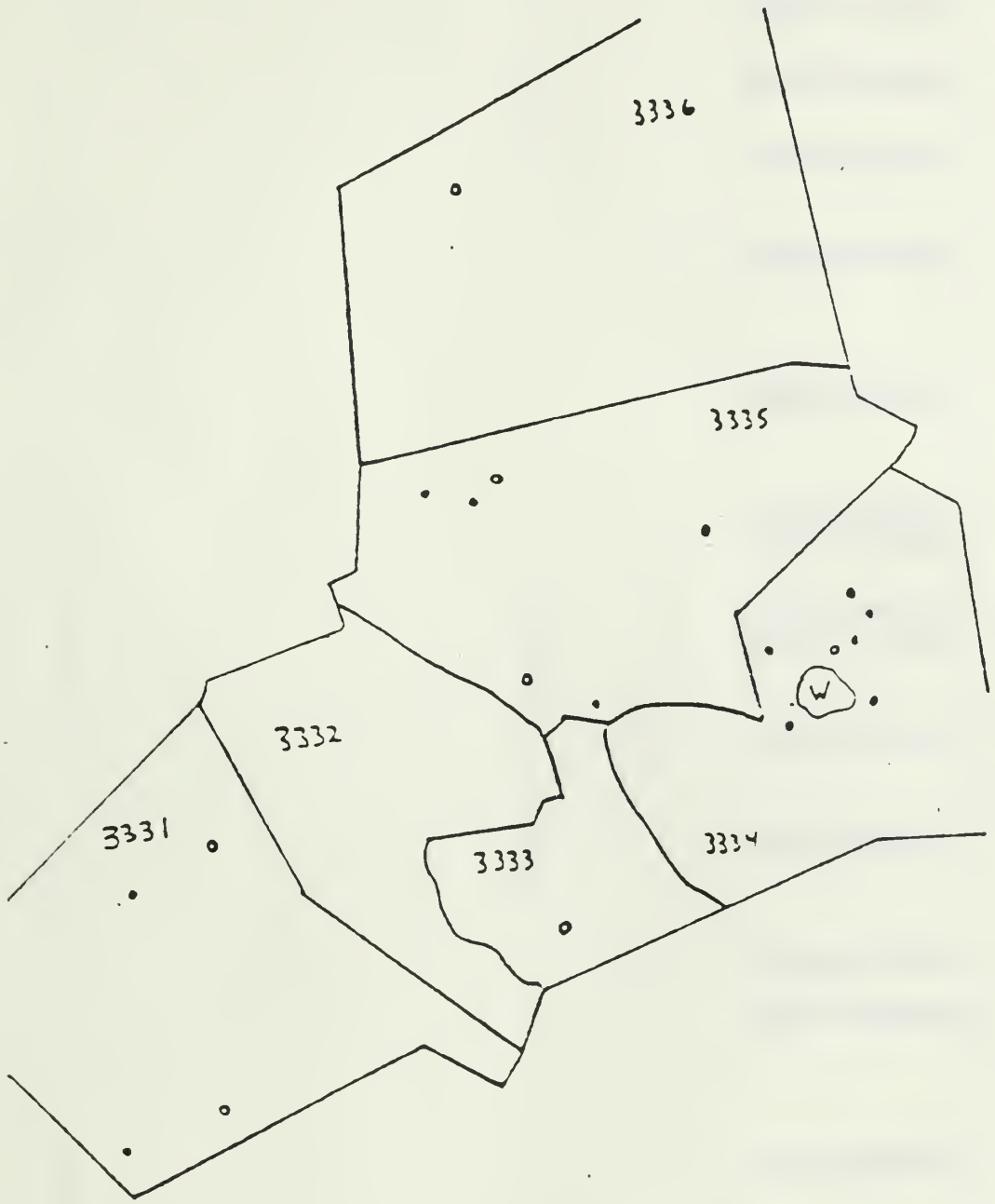
* Fisher exact.

TABLE 5. NUMBER OF OBSERVED AND EXPECTED CASES OF LEUKEMIA (ALL TYPES) BY CENSUS TRACT IN WOBURN, MASSACHUSETTS: JANUARY 1969 - DECEMBER 1983

Number of Cases	Census Tract					
	3331	3332	3333	3334	3335	3336
Observed	4**	0	1*	7*	6**	1*
Expected	1.08	0.82	0.75	.92	1.46	1.00
Poisson probability	0.02	---	0.53	5.0×10^{-5}	0.004	0.74

* Each asterisk represents one new case after 1979.

Figure 1. CASES OF CHILDHOOD LEUKEMIA BY RESIDENCE: WOBURN, MA, JANUARY 1969 - DECEMBER 1983



W= Walker Pond
Numbers are census tracts
● = Date of diagnosis: 1969-1979 (n=12)
o = Date of diagnosis: 1980-December 1983 (n=7)

Figure 2. CHILDHOOD LEUKEMIA IN WOBURN, MA: 1969-1983, BY DATE OF DIAGNOSIS

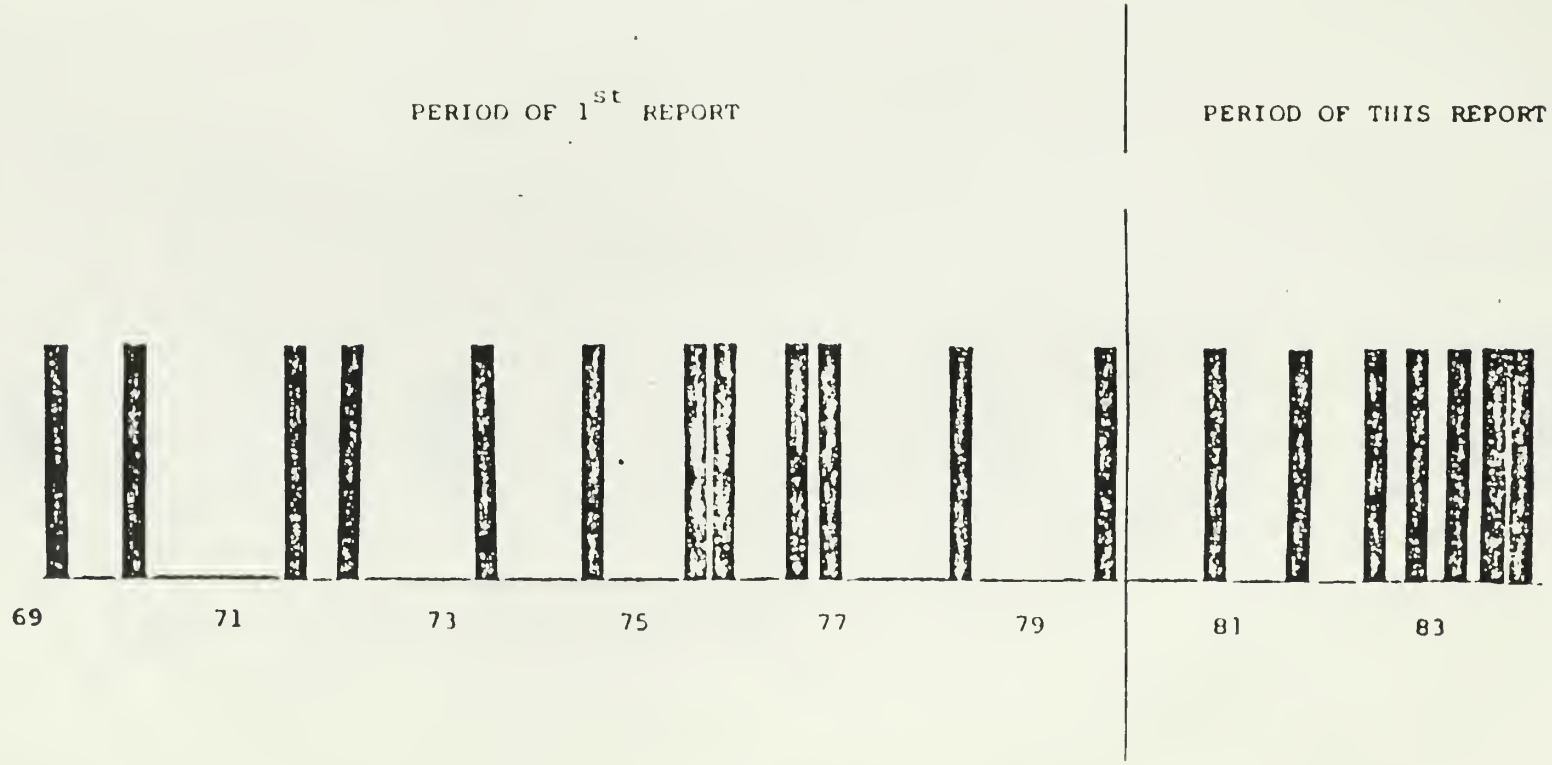
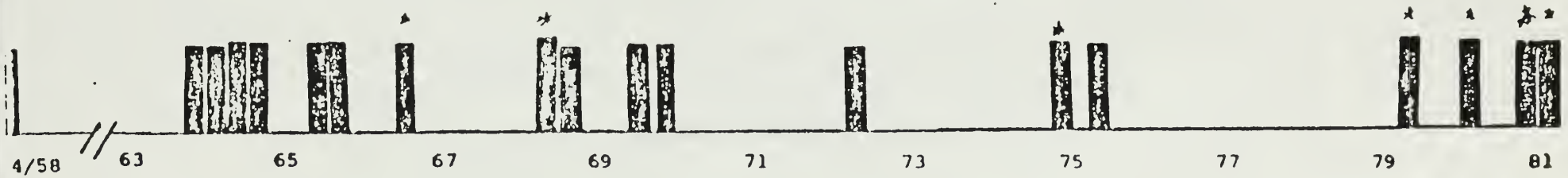


Figure 3. CHILDHOOD LEUKEMIA IN WOBURN, MA: 1969-1983, BY DATE OF BIRTH



* Date of diagnosis: 1980- December 1983